теплую осень, семена зернового сорго, как правило, имеют повышенную влажность, доходящую иногда до 30—35 процентов. А это значит, что обмолоченные комбайном семена зернового сорго требуют немедленной просушки. Для этого мы рассыпаем семена на току тонким слоем и часто перелопачиваем их или сушим в сушилке. Иначе они быстро согреваются и теряют всхожесть. Сушить семена надо до тех пор, пока влажность их будет не более 11—12 процентов, только после этого их можно убирать в зернохранилище.

Несколько иначе обстоит дело с уборкой семян сахарного сорго. Дело в том, что лучшие сорта его отличаются высоким ростом (рис. 2). Сорго сорта Китайский янтарь 813 в наших условиях достигает высоты 3 метра и более, Красный янтарь 271/585 мало уступает ему в росте. В связи с высокорослостью, большой сочностью и сахаристостью стеблей, наличием подгона, в метелках которого семена находятся в различных фазах созревания, убирать семенники сахарного сорго машинами трудно. Главное затруднение состоит в том, что сахаристый сок при обмолоте обволакивает семена, повышает их влажность, семена слипаются. Чтобы избежать этого, целесообразно срезать метелки и досушивать их на току или в сушилках. Можно и до посева хранить их в необмолоченном виде, тем более, что при таком способе семена лучше хранятся.

Таким образом, наши исследования и опыт хозяйств Молдавской ССР показывает, что в каждом колхозе и совхозе можно выращивать необходимое количество семян сорго.

Комплексная термохимическая обработка семян ячменя

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УДК 633.16:631.531.17

ПЕРВОСТЕПЕННОЕ значение в борьбе с болезнями ячменя (каменная и пыльная головня, ржавчина, гельминтоспориозы, плесневение семян) имеет качество посевного материала. В практике сельского хозяйства применяются различные приемы улучшения его качества, такие как очистка и сортирование, химическое и термическое обеззараживание, обработка инсектицидами, микроэлементами, стимуляторами, бактериальными удобрениями и другие.

Все эти приемы способствуют, с одной стороны, удалению или уничтожению инфекции в семенах, а с другой — получению более жизненных растений, которые более устойчивы к болезням, распространяющимся в период вегетации. Наряду с этим обработка некоторыми инсектицидами (гексахлоран, гептахлор) позволяет также в значительной степени защитить семена и всходы от повреждений проволочниками.

В хозяйствах обычно применяют какой-нибудь один прием предпосевной обработки семян, а этого явно недостаточно. Поэтому возникла необходимость объединить хотя бы некоторые из упомянутых приемов в единый комплексный рабочий процесс, который позволил бы при наименьших затратах труда получить

наибольший эффект в отношении защиты растений ячменя от болезней и вредителей и тем самым способствовать повышению урожая и улучшению его качества.

Нами разработан способ, объединяющий в один рабочий процесс следующие приемы предпосевной обработки семян ячменя: влажный обогрев их, протравливание против болезней, обработка гексахлораном против проволочника и микроэлементами для стимуляции роста. Такую комплексную термохимическую обработку проводим следующим образом.

Семена ячменя, предназначенные для посева в течение одного дня, ссыпают в продолговатый (высотой 60—70 сантиметров) ворох в складе на деревянном полу или у склада на цементированной площадке. Затем их в течение суток в три приема увлажняют равными порциями воды, лучше теплой (20 — 30 градусов), тщательно перелопачивая. Воду берут из расчета 34 процента от веса семян. Увлажненное зерно собирают в крутой ворох и покрывают мешковиной или брезентом. Вследствие самосогревания температура в ворохе поднимается до 22—28 градусов. Обогрев в ворохе продолжают 24—28 часов. При обработке семян микроэлементами третье увлажнение проводят растворами из расчета 1 грамм борной кислоты и 1,5—2 грамма сернокислого цинка или марганца (можно использовать марганцовку) на 10 литров воды. Если в хозяйстве имеется препарат НИУИФ-1, им также обрабатывают семена при третьем увлажнении, добавляя на каждые 10 литров раствора микроэлементов 25 кубических сантиметров препарата.

После окончания обогрева, перед высевом, зерно обрабатывают порошкообразными препаратами — гексахлораном (300 граммов на центнер семян) против проволочника или, если не применяли НИУИФ-1, комбинированным препаратом — меркураном (100 граммов на центнер семян) против болезней и вредителей, или порошкообразными протравителями — гранозаном (150 граммов на центнер семян), ТМТД (200 граммов на центнер) только против болезней. В конце обогрева у семян основной массы зародыш под оболочкой зерна слегка приподнят, а 2—5 процентов семян наклюнулось. Такие семена готовы к высеву.

Рис. 1. Растения ячменя:
1—контрольные; *2*—обработанные комплексным способом (влажный обогрев + меркуран + марганец).

Так как в результате увлажнения семена имеют повышенную влажность (20 — 28 процентов), очень важно сохранить установленную норму высева. Для этого нужно взвесить определенное число (лучше 1000) сухих и увлажненных (обогретых) семян и в соответствии с разницей в их весе, увеличить норму высева обработанных семян. Если семена по какой-либо причине нельзя высеять на следующий день, их нужно рассыпать тонким слоем.

Вариант опыта	Пораженность растений (%)								
	полосатой пятнистостью (H. graminеum)	стеблевой ржавчиной	всходов гельминтоспориозом	сетчатой пятнистостью (H. teres)		всходов гельминтоспориозом	каменной головней	корневой гнилью
	полевая станция ТСХА	совхоз „Большевик" (Московская обл.)			учхоз „Дубки" (Моск. обл.)		колхоз „Заветы Ленина" (Тульская обл.)	
Контроль	19,2	5,3	24,7	6,2	29,8	15,2	7,5	8,0	7,5
Комплексная обработка	0,2	0,0	7,8	0,0	20,9	7,1	0,0	0,08	2,5

Нашими многочисленными лабораторными и полевыми опытами установлено, что комплексная предпосевная обработка семян ячменя, активизируя деятельность ферментов, усиливает начальный рост и развитие растений. Развитие последующих фаз также проходило ускоренно, созревание наступило на 1—5 дней раньше. Растения из обработанных семян были более устойчивыми к болезням (табл.), чем из необработанных.

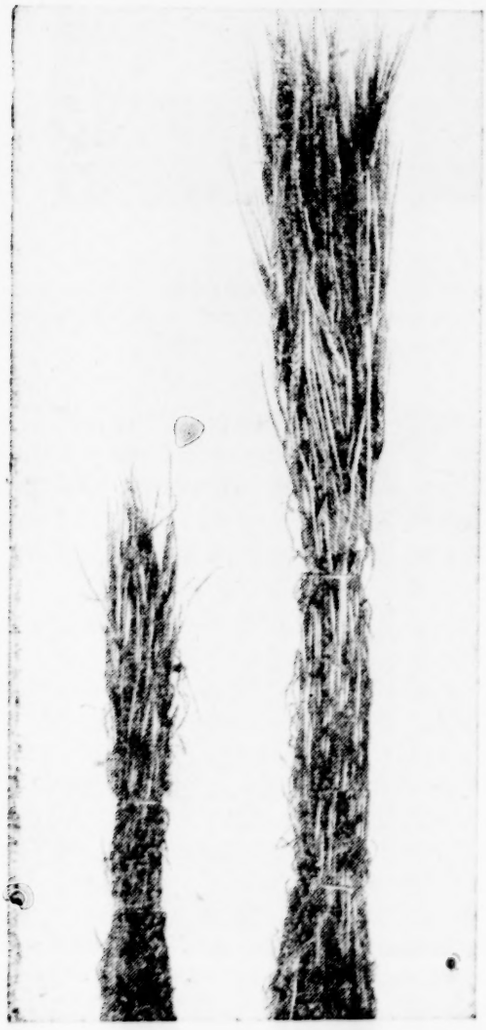

Рис. 2. Растения ячменя: слева—пораженные гельминтоспориозом, справа—здоровые.

Из таблицы видно, что включение в комплексную обработку семян эффективных протравителей (меркуран, гранозан) полностью освободило всходы ячменя от первичной инфекции гельминтоспориозов, а это имеет большое значение для ликвидации очагов вторичного заболевания растений (рис. 2). От протравливания формалином подобных результатов не получают.

Интересен и характер проявления сетчатого гельминтоспориоза на растениях из семян, обработанных марганцем, бором и гексахлораном. Эти растения созревали на несколько дней раньше контрольных и к моменту массового распространения болезни находились уже в фазе начала восковой спелости. На их листьях гельминтоспориоз проявился в виде мелких несливающихся темных точек. Более ранним созреванием растений из обработанных семян, очевидно, было вызвано и резкое снижение (в 3 раза) пораженности ячменя стеблевой ржавчиной.

В наших опытах поражение ячменя головней было очень незначительным. Только в одном из них (в колхозе «Заветы Ленина», Тульской области) растения сильно поражались каменной головней. На контрольном участке, где высевали семена, протравленные гранозаном (1,5 килограмма на тонну семян), количество пораженных растений

достигало 8 процентов, а на рядом расположенном участке, где были высеяны семена, протравленные гранозаном в той же дозе, подвергнутые влажному обогреву и обработке бором, количество заболевших растений исчислялось сотыми долями процента. Повышение эффективности протравителей в уничтожении грибной инфекции, находящейся под пленкой семени, при сочетании их с влажным обогревом семян и обработкой микроэлементами вызвано тем, что в процессе обогрева гриб трогается в рост и становится более уязвимым для действия препарата. В том же опыте наблюдалось значительное (в 3 раза) снижение пораженности ячменя корневой гнилью.

Благодаря слабой пораженности болезнями и лучшему развитию опытные растения дали урожай выше, чем контрольные, на 19—38 процентов. Так, по данным производственных опытов, проведенных в хозяйствах Московской области, урожаи ячменя на опытных участках (засеянных обработанными семенами) составили: в 1961 году в совхозе имени Димитрова — 17,8 центнера с гектара, в совхозе имени Тельмана — 10,5, в 1963 году в совхозе «Звенигородский» — 20,9 и в колхозе «Заветы Ленина» — 18 центнеров, на контрольных участках соответственно 14,6; 7,6; 16,7 и 13,2 центнера.

Заметная прибавка урожая зерна (на крупноделяночных опытах) была получена также и в случае применения отдельных элементов комплексной обработки. Например, влажное прогревание семян повысило урожай ячменя в среднем по всем опытам на 12 процентов, сочетание обогрева с опудриванием гексахлораном — на 16, марганцем — на 20 и бором — на 17 процентов. Следует отметить, что включение в комплексную обработку семян ГХЦГ или меркурана снижало в 2—4 раза поврежденность всходов проволочниками и улучшало развитие растений.

Улучшались и посевные качества зерна, выращенного из семян, подвергнутых комплексной обработке. Так, уборочная влажность зерна с контрольных участков была 22,3 процента, с опытных — 19,7, вес 1000 зерен соответственно 48,3 и 50,4 грамма, зараженность семян уменьшилась более чем в 2 раза.

Теперь несколько слов об экономической эффективности комплексной обработки. Наши подсчеты показали, что небольшие дополнительные затраты на нее (один рабочий день на 3 гектара посева и стоимость препаратов) хорошо окупаются получаемой прибавкой урожая. Себестоимость одного центнера зерна при такой обработке на 20 процентов ниже, чем при обычной. В настоящее время на кафедре механизации ТСХА заканчиваются работы по механизации наиболее трудоемких процессов при комплексной термохимической обработке семян зерновых хлебов.

Мы считаем целесообразным провести более широкое производственное испытание этого способа и применять его в первую очередь для семян, предназначенных для семенных посевов. Если в хозяйствах нет микроэлементов, можно рекомендовать как наиболее доступный, влажный обогрев в сочетании с обработкой инсектофунгицидами. Целесообразно было бы создавать также новые инсектофунгициды, содержащие и микроэлементы.

ния в воздух, что в свою очередь значительно улучшает санитарно-гигиенические условия работы.

В 1961 году научными сотрудниками ВИЗРа была проведена производственная оценка протравливания семян с увлажнением в совхозах «Вишневский», «Бирсуатский», «Подлесный», «Самарский» и «Чаглинский», Целиноградской и Кокчетавской областей. Препаратами ТМТД и гранозаном было протравлено 5860 тонн семян пшеницы. Это обеспечило прибавку урожая зерна на 1 центнер с гектара. В 1962 году в Целиноградской, Кокчетавской и Северо-Казахстанской областях было протравлено с увлажнением 117 тысяч тонн семян, прибавка урожая зерна составила 1—1,5 центнера на каждом гектаре. В 1963 году во всех пяти областях Целинного края было обработано уже 699 тысяч тонн семян.

Однако внедрение в практику совхозов и колхозов протравливания суспензиями зерновых, зернобобовых культур и свеклы тормозится из-за отсутствия специальных машин, пригодных для этой цели. В настоящее время заканчиваются производственные испытания протравочной машины ПЗ-10, сконструированной Всесоюзным институтом защиты растений и СКБ Львовского машиностроительного завода. С ее помощью можно будет протравливать семена многих культур суспен-

тов;

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Второй способ протравливания порошковидными препаратами с увлажнением заключается в том, что на семена наносят одновременно протравитель и воду. В воде может быть растворено клеющее вещество, благодаря чему удерживаемость препарата на поверхности семян повышается. При современном уровне механизации протравливания второй способ может найти самое широкое применение. Так, его можно проводить с помощью зернопротравителя ПУ-3 и ПУ-1. Перед началом работы машины регулируются на норму расхода порошковидного препарата, как при сухом способе, а затем производится регулировка на расход воды. Во время протравливания препарат и вода попадают на семена и перемешиваются между собой при перемещении к выходному отверстию. Производительность ПУ-3 3—6 тонн семян в час, ПУ-1—1,5—2 тонны.

Для обработки больших партий семян протравителями рекомендуется использовать приспособления к автозагрузчику АС-2. Такое приспособление (рис.), представляет собой небольшой бункер для порошковидного препарата с дозирующим устройством. Бункер крепится на зерновом бункере загрузчика с помощью стоек. Дозирующее устройство приводит в движение привод от вала горизонтального шнека. Ядохимикат поступает на семена по на-

MILENKO, Ya.F. (Ukr. Res. Inst. Pl. Cult. Selec. Gen.) 1964

Ochistka semyan Podsolnechnika ot sklerotsiev belo gnili. [Cleaning of white rot (Sclertiana sclerotiarum) sclerotia from Sunflower seeds.]

Sel. Seed Gr., Moscow, 29 (2): 73-74, 1964.

Microfilm no. 11,304

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годен бак от комбайнов С-6 на 120 литров). От бака отводится металлическая трубка, по которой подается вода для смачивания семян, подача ее в пределах 5—10 литров на тонну семян регулируется с помощью крана.

Порядок протравливания следующий. При помощи скребкового зернопогрузчика наполняют зерновой бункер автопогрузчика. Одновременно от двигателя автомашины приводятся в движение все вращающиеся части, кроме колес, а также шнек дозатора, который продвигает ядохимикат к выпускающей щели бункера. В это время открывается кран подачи воды для увлажнения по указанной норме.

Семена, смоченные водой, и ядохимикат захватываются в проеме зернового бункера наклонным шнеком и перемещаются к горизонтальному шнеку, где и происходит дальнейшее перемешивание их. Производительность такого приспособления в условиях стационарной работы — 17 тонн семян в час. Обслуживают зернопротравитель шофер и двое рабочих. Протравливать семена с помощью этого приспособления можно как заблаговременно, так и непосредственно перед посевом.

Для протравливания семян с увлажнением могут быть использованы и другие приспособления, обеспечивающие расход заданной нормы ядохимиката и воды и тщательное их смешивание с семенами.

Нормы расхода протравителей при протравливании суспензиями или с увлажнением такие же, как и при сухом протравливании, расход воды — 5—10 литров на тонну семян. Эффективность протравливания с увлажнением значительно выше, чем при сухом протравливании, за счет устранения потерь препаратов, а также за счет длительности их действия, если семена обрабатывались заблаговременно.

Протравливание семян — широко доступное и дешевое мероприятие. Расходы на его проведение хорошо оплачиваются прибавкой урожая. Так, по подсчетам экономистов ВИЗРа М. А. Глебова и В. Г. Степиной, стоимость протравливания гранозаном одной тонны семян (стоимость ядохимиката, зарплата рабочим, оплата горючего, отчисления на амортизацию) в совхозе «Вишневский», Целиноградской области, при использовании приспособления к автопогрузчику АС-2 составила 82 копейки, то есть затраты на один гектар были 11,2 копейки. Средняя стоимость протравливания одной тонны семян пшеницы в Актюбинской области была 1 рубль 03 копейки, затраты на гектар—14 копеек; прибавка урожая за счет протравливания — около одного центнера на гектар. Выгодность этого мероприятия очевидна.

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ОЧИСТКА СЕМЯН ПОДСОЛНЕЧНИКА ОТ СКЛЕРОЦИЕВ БЕЛОЙ ГНИЛИ

Водный способ

Значительный ущерб урожаю подсолнечника наносит поражение его наиболее распространенным и вредоносным заболеванием склеротиния (белая гниль), возбудителем которого является грибок Sclerotinia Libertiana Fuck. Наукой разработаны профилактические меры борьбы с этим заболеванием. К ним относятся: а) отбор на семенных посевах здоровых, не пораженных склеротинией корзинок; сушка семян до 7—8 процентов влажности и хранение их в мешках в сухом проветриваемом помещении; б) глубокая зяблевая пахота плугами с предплужниками; в) содержание посевов в чистом от сорняков состоянии; г) обязательное соблюдение установленного севооборота; д) прочистка посевов от больных растений с момента прорывки до уборки (больные растения глубоко закапывают в почву или сжигают); е) протравливание семян химическими препаратами (меркураном или ТМТД) за 3—4 недели до посева.

Однако даже при выполнении этих мероприятий подсолнечник в какой-то степени поражается склеротинией и при уборке в семена попадают склероции — черные не-

правильной формы плотные образования гриба.

В 1963 году в одном из хозяйств Великобурлукского производственного управления было обнаружено сильное засорение склероциями партии сортовых семян подсолнечника (115 центнеров), предназначенных для семенных целей. Чтобы избавиться от склероциев, начали перебирать семена вручную. Но за 10 дней пять рабочих с трудом очистили 20 центнеров. Поэтому оставшиеся семена решили очистить от склероциев путем промывки семян водой.

Работу проводили следующим образом. Подогревали воду до 45—50 градусов и резиновым шлангом подавали ее в заранее подготовленные ванны. На каждые 100 килограммов семян брали 200 литров подогретой воды. Семена высыпали в ванну с водой и 15 минут помешивали деревянной мешалкой. Все склероции оседали на дно ванны, а семена всплывали. Их с поверхности воды собирали веялочными решетами и рассыпали на брезенты для просушки.

По данным КСЛ Великобурлукского производственного управления, куда были сданы образцы для анализа, высушенные семена оказались кондиционными, склероциев не было обнаружено. Это дает нам основание рекомендовать вышеописанный способ для практического применения.

Я. Ф. МИЛЕНКО
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Механический способ

Институт сельского хозяйства Центрально-черноземной полосы имени В. В. Докучаева в начале 1963 года обратился в ВИМ с просьбой помочь найти способы очистки семян подсолнечника от склероциев белой гнили (склеротиния). Внешне склероции белой гнили сходны с почерневшими гладкими округлыми комочками земли и по размерам мало отличаются от семян подсолнечника.

Чтобы решить, при помощи каких технических средств можно отделить склероции от семян, мы изучили физико-механические свойства (толщину, ширину, длину, парусность и удельный вес) семян подсолнечника и склероциев белой гнили и, основываясь на этих свойствах, разработали схему технологического процесса очистки семян подсолнечника, включающую решета с круглыми и продолговатыми отверстиями, воздушный поток, триер и пневматический сортировальный стол (рис.).

При разработке технологической схемы использовали неочищенные семена (ворох) сортов Передовик, Армавирский 3497, ВНИИМК 1646, ВНИИМК 6540, ВНИИМК 8931, Ждановский 8281, Пионер Сибири, Саратовский 169 и Степняк, у которых толщина изменяется от 1,5 до 5,5, ширина — от 3,5 до 9 и длина — от 7 до 14—15 миллиметров. Ворох, получающийся при обмолоте корзинок, обычно состоит из семян подсолнечника, нормально развитых, голых, мелких и щуплых, склероциев белой гнили, кусочков корзинок, стеблей, листьев и мелкого сора.

Согласно нашей схеме, приведенной на рисунке, ворох неочищенных семян (А) вначале направляется на решето с круглыми отверстиями диаметром 8—10 миллиметров. На этом решете из семенного материала отделяются крупные примеси (куски корзинок, стеблей и т. п.), которые выводятся наружу (выход 1). Семенной материал, прошедший через отверстия первого решета, попадает на второе с круглыми отверстиями в 4,5—5 миллиметров. На этом решете от вороха через отверстия отделяются мелкие примеси, в том числе мелкие склероции белой гнили, очень мелкие семена подсолнечника (выход 3), а сход поступает на третье решето с продолговатыми отверстиями шириной 2,5—3 миллиметра, через которые проходят мелкие примеси, склероции, голые и щуплые семена подсолнечника (выход 4). Воздушным потоком, создаваемым в сортировальном канале вентилятором, от семян, идущих сходом с решета, отделяются легкие примеси и очень легкие семена подсолнечника (выход 2).

После очистки на решетах и воздухом семена направляются в триер с ячейками диаметром 8,5 миллиметра, где разделяются на две части. Одна из них (короткие примеси, склероции белой гнили, голые и очень короткие семена подсолнечника) забрасывается ячейками триера в желоб и выводится наружу (выход 5); другая (се-

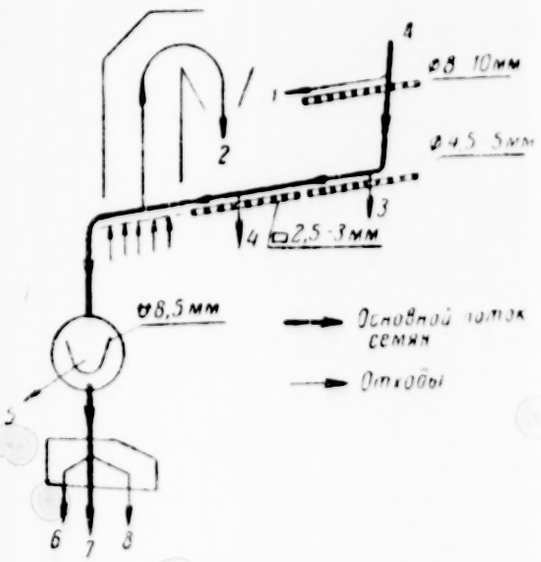

Схема технологического процесса очистки и сортирования семян подсолнечника.

А—исходный семенной материал; *1*—крупные примеси; *2*—легкие примеси; *3*, *4*—мелкие примеси; *5*—короткие примеси; *6*—тяжелые примеси (склероции); *7*—очищенные семена; *8*—легкие примеси.

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ROOT-ROT OF COTTON IN MAHARASHTRA AND GUJARAT STATES CAUSED BY *MACROPHOMINA PHASEOLI*

MONIZ, L. & BHIDE, V.P. (Poona Univ.). 1963

Root-rot of Cotton in Maharashtra and Gujarat states caused by Macrophomina phaseoli (Maubl.) Ashby var. indica n. var.

Indian Cott. Gr. Rev., 17 (5): 292-302, 2 tables, 1963.

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Though root-rot has been investigated quite intensively in India during the last to investigating the pathogen in detail since this aspect of the disease, as it occurs in Western India has not so far received adequate attention.

Review of literature

Butler (1918) first reported cotton root-rot in U.P. and Madras. Dastur (1929, 1931) reported seedling blight of cotton in the then C.P. and Berar, which he later termed 'dry-rot' or 'sore-shin' caused by *Macrophomina phaseoli*. His many attempts to reproduce the disease failed but inoculation of leaves was successful. Subsequently, the disease was reported from other cotton growing regions of India. Small (1926) reporting root-rot from Uganda thought it would always occur if the causal agent (*Rhizoctonia bataticola*) was present in the soil. Briton-Jones (1927) in Trinidad could not accept this statement since his experiments indicated that special conditions were necessary to incite the disease besides presence of the pathogen. West and Stucky

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The pathogen was critically investigated by Reichert and Hellinger (1927) in Palestine. They studied isolates of *M. phaseoli* from bean, egg plant, potato, pepper, *gram* (*Cicer arietinum* L.), tomato, pumpkin, tobacco and cotton and divided them into three classes which were called sub-species, *viz.*, *typica*, *sesamica* and *intermedia* on the basis of pathogenicity and characters of mycelium, the cotton isolate falling in the *intermedia* class. They also listed 118 hosts of the pathogen from Palestine alone and 132 from other countries and observed that root-rot was limited in its geographical distribution by humidity and high temperature. Uppal (1934) working with root-rot of Gujarat cottons observed that plants took up infection at soil temperatures of 30° to 34°C., but manifestation of external symptoms depended on air temperature. On the other hand, Vasudeva and Ashraf (1939) observed highest mortality due to root-rot in the Punjab at soil temperatures of 35° to 39°C. They further observed that a mixed crop of *jowar* (*Sorghum vulgare*) or *math* (*Phaseolus aconitifolius*) and cotton grown in a fully infested field reduced mortality due to root-rot considerably by reducing soil temperature. Vasudeva (1944, 1945) further observed that leaves of root-rot affected cotton plants were warmer than those of healthy ones. His attempts to control the disease by soil fumigation, change in cultural methods and application of fertilizers gave inconclusive results. Tarr (1956) obtained similar results using chloropicrin as a soil fumigant. As regards control of root-rot through resistant varieties, Luthra and Vasudeva (1941) tested a large number of indigenous and exotic varieties in the Punjab, in a highly infested field and found no variety resistant. Govande (1942) in Gujarat could obtain a variety by continuous selection on *G. herbaceum* which gave about 20-30 per cent mortality in different families but complete resistance was not possible.

Symptoms

Root-rot of cotton is characterised in the field by the sudden wilting of infected plants in the flower and boll stage. Every leaf on such a plant droops down and plants which appear perfectly healthy are killed sometimes within 24 hours. Such plants never recover. If the root system of infected plants is exmined it is observed that only the tap root and a few secondary roots are intact, the rest having decayed. The tip of the tap root is usually moist and sticky whereas the bark is extensively shredded and comes off easily, showing a brown discolouration of the exposed area. Root-rot in the field invariably occurs in circular patches which may enlarge but the disease in subsequent years is not necessarily restricted to the previous patches.

Isolation

The causal organism was easily brought into pure culture by the usual method of planting pieces of diseased tissue in plates of potato dextrose agar which were then incubated at 30°C. Growth of the fungus was visible within three days and was transferred to slants of potato dextrose agar; sclerotia were profusely formed within three days in these slant culture.

Pathogenicity

Root inoculation : The fungus was grown on sterilised corn-meal sand (1-1) medium in large Kilner jars at 30°C. and at intervals of 24, 48 and 72 hours the mycelial mat was carefully removed with a sterile spatula so

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By

L. MONIZ and V. P. BHIDE

Introduction

Root-rot is a serious disease of cotton in Gujarat and Maharashtra States, all cultivated species, varieties and strains being susceptible. The disease is also serious in the Punjab where it has been investigated extensively. The root-rot pathogen is widespread and it could be said that the disease occurs in all cotton growing regions of the world.

Vasudeva (1935) thought that the disease in the Punjab resembled root-rot as it occurred in Texas—(U.S.A.) and that the disease in Gujarat cottons was different in some respects. Likhite (1935, 1936) reported that nematodes were associated with root-rot in Gujarat. He also made a survey of the disease in 92 villages in Gujarat and observed incidence of root-rot from 5 to 50 per cent. Peltier (1926) observed bronzing or yellowing of root-rot affected plants in Texas, which preceded wilting but this symptom was not recorded by Vasudeva (1935) in the Punjab. He also observed that the pathogen in the Punjab rarely formed sclerotia on the host plant but this was not the case with the pathogen in Gujarat. Further, in Gujarat maximum mortality occurred when the crop was in the flower and boll stage, whereas in the Punjab plants succumbed when only two months old.

Though root-rot has been investigated quite intensively in India during the last 40 years it has not been possible to reproduce the disease artificially under controlled conditions. Since the final solution of root-rot control would justifiably lie in evolution of resistant types of cotton, as has been the case with *Fusarium* wilts, a technique for testing cotton material for resistance to root-rot under artificial conditions is a logical prerequisite. It was with this primary object that the present investigation was undertaken, as also with a view to investigating the pathogen in detail since this aspect of the disease, as it occurs in Western India has not so far received adequate attention.

Review of literature

Butler (1918) first reported cotton root-rot in U.P. and Madras. Dastur (1929, 1931) reported seedling blight of cotton in the then C.P. and Berar, which he later termed 'dry-rot' or 'sore-shin' caused by *Macrophomina phaseoli*. His many attempts to reproduce the disease failed but inoculation of leaves was successful. Subsequently, the disease was reported from other cotton growing regions of India. Small (1926) reporting root-rot from Uganda thought it would always occur if the causal agent (*Rhizoctonia bataticola*) was present in the soil. Briton-Jones (1927) in Trinidad could not accept this statement since his experiments indicated that special conditions were necessary to incite the disease besides presence of the pathogen. West and Stucky

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as not to break the mycelial strands. Some soil near the root zone of young cotton seedlings growing in steamed soil in earthen pots was carefully uplifted, the mycelial mat was placed in the cavity and the soil returned to its position. A large number of plants were thus inoculated and the pots were kept at a soil temperature of 28°C., in Wisconsin soil temperature tanks in a glass house together with an adequate number of control (uninoculated) plants. The air temperature in the glass-house fluctuated between 26°C. and 35°C., during the test period. The pots were lightly watered twice a day taking care not to disturb the soil. The disease appeared 3 days after inoculation and progressed rapidly thereafter. Maximum mortality occurred in pots inoculated with 48 hour old cultures. Diseased seedlings showed the characteristic symptom of shredding of the barkand discoloration and all the lateral roots were damaged in this manner. The fungus was easily re-isolated from such plants.

Leaf inoculation : The ability of *Macrophomina phaseoli* to infect living leaves of cotton plants was first established by Neal (1944) in Louisiana, U.S.A. where he had observed leaf symptoms in nature. In order to determine whether the Indian strain of *M. phaseoli* could infect leaves an inoculation experiment was conducted using the Indian isolate under investigation and a type culture of *M. phaseoli*. Leaves of young cotton seedlings, raised in steamed soil in earthen pots in a glass-house were inoculated with mycelial bits of the two cultures separately, the pots were kept under moist chambers for 12 hours prior to and after inoculation. Typical lesions were visible 6-7 days after inoculation on plants inoculated with both the cultures whereas control plants remained without symptoms. Young lesions were small, light-brown, irregularly shaped and limited by veins but spread rapidly giving a crinkled appearance to inoculated leaves. The two fungi were easily re-isolated from these lesions.

Physiological Characters of the Fungus

Relation of temperature to growth in culture

The temperature-growth relation of the fungus was studied on potato dextrose agar plates kept at various incubation temperatures. Each plate was inoculated in the centre with a sclerotium of the fungus and duplicate inoculated plates were carried at temperatures from 5°C to 40°C., for 8 days when colony diameters were measured. *M. phaseoli* (type culture) was also included in this test for comparison. No growth occurred at 5°C. and 40°C., best growth was observed between temperatures of 31°C. to 36°C., which seems to be the optimum temperature range for growth in culture. Vasudeva (1936) working with the Punjab isolate of the pathogen, obtained growth upto 30°C., after which there was a decline and growth ceased at 40°C. It would, therefore, appear that the fungus under study has a higher optimum temperature for growth than the Punjab strain but it agrees with *M. phaseoli* (type culture) in this respect.

Utilisation of carbon sources : Luthra and Vasudeva (1940) working with the Punjab strain of *M. phaseoli* observed that glucose, sucrose, maltose, dextrin and soluble starch supported good growth of the fungus but not lactose and galactose. In the present experiment the fungus on hand and *M. phaseoli* (type) were grown on Richards' agar (without sucrose) to which the following carbon sources were added at one per cent level: dextrose, sucrose, inulin, mannitol, raffinose, rhamnose, dextrin, lactose, levulose, dulcitol, salicin and maltose. Plates poured with the media were inoculated and incubated at 30°C. for 6 days when colony diameters and production of sclerotia was recorded. Both *M. phaseoli* (type) and the fungus under study utilised dextrose, sucrose, raffinose, levulose and maltose for growth and production of sclerotia; lactose was well utilised by the fungus under study but poorly by *M. phaseoli* (type).

Utilisation of nitrogen source : Vasudeva (1937) reported that nitrogen in the form of ammonium salts exerted a toxic effect on the Punjab strain of *M. phaseoli* whereas calcium nitrate and peptone supported good growth. In the present experiment the following nitrogen sources were tested at 0.1 per cent level : sodium nitrite, sodium nitrate, potassium nitrate, magnesium nitrate, barium nitrate, calcium nitrate, ammonium phosphate (mono and dibasic), ammonium tartarate, ammonium nitrate and ammonium sulphate. The basal medium of the following composition as recommended by Mushim (1938) was used : K_2HPO_4-3.1 gm., KH_2PO_4-0.8 gm., KCl-0.2 gm., $MgSO_4$-0.2 gm., dextrose-10 gm., agar-20 gm. and distilled water-1 litre. The media were made neutral to brom-thymol-blue, plates were poured, inoculated and incubated at 30°C., for 8 days. *M. phaseoli* (type) was also used along with the fungus under study. Both the fungi grew well on all the media except those containing sodium nitrite and sodium nitrate where growth was submerged ; no toxic effect was observed in the case of ammonium salts.

In another experiment the ability of the two fungi to utilise amino acids as sources of nitrogen was studied. The basal medium and other procedure was the same as before ; the following amino acids were used at 0.1 per cent level : DL-serine, DL- threonine, DL-B-phenylalanine, DL-valine, glycine, L-glutamic acid. DL-tryptophane, guanidine hydrochloride, DL-norleucine, asparagine, creatine, DL-aspartic acid, DL-a-alamine, glycocyamine and creatinine. Both the fungi utilised all the amino acids and grew well.

Production of extracellular enzymes : The extracellular enzymatic activity of the fungus under study and of *M. phaseoli* (type) was studied by growing them on a basal salts medium to which different zymolytes were added as per method recommended by Cabrill and Reed (1915). Production of enzyme was evidenced either by ability to the fungi to grow or by specific colour reactions. The inoculated plates were incubated at 30°C., for 8 days. Both the fungi produced inulase, amidase, diastase, trypsin and emulsin ; the fungus under study also produced cytase and erepsin ; in large amounts but *M. phaseoli* produced cytase meagerly and erepsin not at all. Both the fungi, however, did not produce gelatinase.

Effect of hydrogen ion concentration on growth in culture : The effect of pH on growth in culture was studied in Richards' agar adjusted to various pH levels by addition of 0.1 NaOH and H_2SO_4 ; Beckman's pH meter with a glass electrode was used for this purpose. More than 2 per cent. agar was necessary for solidifying the more acidic media. Before inoculation of plates the final pH of the sterilised medium was recorded for which small portions were separately sterilised in tubes. The inoculated plates were incubated at 30°C., and colony diameters were measured after 8 days. The fungus under study grew well between pH 3 and 11.8 whereas *M. phaseoli* (type) could not grow at the lower level ; optimum pH for both the fungi was around neutrality.

Tolerance to common salt : Both the fungi could tolerate high concentrations of common salt upto 10 per cent in Richards' agar at 30°C., though growth was poor at concentrations of 9 and 10 per cent.

Effect of tyrosine on growth : Both the fungi grew well in Richards' agar to which 0.5 per cent tyrosine was added ; however, the medium was blackened in 5 days by the fungus under study, which was not the case with *M. phaseoli* (type).

Effect of soil temperature on the disease : It is generally recognised that soil temperature exerts a marked influence on the severity of soil borne fungus diseases and this phenomenon has been fully investigated in *Fusarium* wilts (Gilman, 1916, Tisdale, 1917, 1923, Tims, 1926, Clayton, 1923, Uppal and

Kulkarni, 1937, Bhide and Uppal, 1948). In the case of cotton root-rot, Vasudeva and Ashraf (1939) found that highest mortality occurred at soil temperatures between 35° and 39° C. In the present investigation, it has already been reported earlier that a constant soil temperature of 30° C. was conducive to development of root-rot in infection experiments. In order, therefore, to determine the most optimum soil temperature for development of root-rot this experiment was undertaken in Wisconsin soil temperature tanks maintained at different soil temperatures in a glass-house at Poona. Galvanised iron cans to be used in soil temperature tanks were filled with steamed, finely sieved red river bottom soil and its moisture content was adjusted to 20 per cent on oven dry basis. Seeds of cotton (*G. herbaceum* variety Broach 9), previously surface sterilised were then sown in these cans which were then kept in the soil temperature tanks ; three soil temperatures were maintained 28° C., 32° C. and 35° C. and there were two cans at each temperature. Watering of the cans was done as and when required and the seedlings, when 15 days old were inoculated with the fungus by the method already described earlier. Root-rot appeared within 24 hours of inoculation and progressed rapidly for a week, after which no further deaths occurred. Severity of root-rot was less at higher temperatures ; maximum incidence was at 28° C. The experiment was continued for a month. The results are recorded in Table 1.

TABLE—1 *Effect of Soil Temperature on Incidence of Root-Rot*

Soil temperature C	No. of plants under test	Progressive total of wilted plants in days									Incidence of disease (per cent)
		1	2	3	4	5	6	7	14	30	
28	51	8	18	25	35	40	45	46	46	46	90.0
32	57	11	18	20	21	22	23	23	23	23	40.0
35	52	—	8	10	11	11	11	11	11	11	21.0

It is seen from these results that the fungus causing root-rot of cotton in Gujarat is at its peak at a lower soil temperature than is the case with the Punjab organism since Vasudeva and Ashraf (1939) reported maximum development of root-rot in the Punjab at temperatures between 35° C. and 39° C.

Effect of soil moisture on the disease

Like soil temperature, soil moisture has a profound effect on soil borne fungus diseases ; in fact soil temperature and soil moisture are the two chief criteria that determine the severity of these diseases, as has been amply demonstrated by Clayton (1923) for tomato wilt, Johnson and Hartman (1919) for tobacco root-rot and Uppal and Kulkarni (1937) for sann-hemp (*Crotalaria juncea*) wilt. In the case of cotton root-rot caused by *M. phaseoli*, Likhite and Kulkarni (1934) observed maximum development in Gujarat ; on the other hand Vasudeva (1935) in the Punjab found 15 to 20 per cent soil moisture conducive to root-rot and no disease occurred in dry soil having only 5 per cent moisture. The

present experiment was, therefore, carried out to determine the optimum soil moisture level for development of root-rot. Finely sieved river bottom soil was steamed and filled in galvanised iron cans to be used in Wisconsin soil temperature tanks ; the soil was previously dried to constant dry weight and its moisture holding capacity was determined. The cans were then adjusted in duplicate to moisture levels of 20, 25, 30 and 35 per cent and the weight of each can was recorded ; delinted seeds of cotton, variety Broach 9, were sown in each can and normal watering was done until seedlings had established. Subsequently, loss of moisture in each can was made up daily by adding water to make up the weight of each can. The plants, when 15 days old were inoculated by the method already described and adequate uninoculated controls were provided. A weighed amount of fine sand was spread on the soil in each can to prevent excessive loss of moisture.

Wilting started 3 days after inoculation and progressed rapidly upto 8 days, after which no further deaths occurred. Maximum wilting took place at 20 per cent soil moisture level and was less at higher levels. The experiment was continued for a month and was repeated by resowing the pots and inoculation of seedling as before ; identical results were obtained in the repeat test. The results are recorded in Table II.

TABLE II.—*Effect of Soil Moisture on Incidence of Root-Rot*

Soil temperature (Per cent)	No. of plants under test	Progressive total of wilted plants in days								Incidence disease (per cent)
		1	2	3	4	5	6	14	15 to 30	
20	26	8	15	22	23	24	24	24	24	92.3
25	26	5	8	12	14	16	17	17	17	65.3
30	16	3	5	6	7	7	7	7	7	43.7
35	19	4	5	6	7	7	7	7	7	36.8

Host Range

Macrophomina phaseoli has a very wide host range spread over many species in unrelated genera and families and including annuals and woody plants as well. Reichert and Hellinger (1927) reported 118 hosts of this fungus in Palestine alone and 132 from countries of S.E. Asia. Root-rot or charcoal rot, incited by *M. phaseoli* is mainly limited to regions where high temperate and high humidity obtain simultaneously although the disease is found in temperate regions also. Young (1949), who made a detailed study of charcoal rot in East Texas in U.S.A. has given a host index of "attainable completeness" which cites 287 hosts reported from all countries.

In the present study the ability of the fungus on hand to incite the disease on commonly cultivated crops, garden and orchard plants in Maharashtra and Gujarat was investigated by an inoculation experiment. The test plants were raised in galvanised iron cans in steamed soil and when one month old, they were inoculated with the fungus by the method already described earlier. Adequate uninoculated controls were provided in each case. The cans were then placed in Wisconsin soil temperature tanks adjusted to 28°C. The test was run for a month.

The following plants, besides cotton (*G. herbaceum*) were successfully inoculated.

Abelmoschus esculentus, *Zea mays*, *Sorghum vulgare*, *Triticum vulgare*, *Saccharum officinarum*, *Paspalum scrobiculatum*, *Phaseolus vulgaris*, *Crotalaria juncea*, *Cicer arietinum*, *Vigna sinensis*, *Dolichos lablab*, *Dolichos biflorus*, *Nicotiana tabacum*, *Solanum melongena*, *Capsicum frutescens*, *Sesamum indicum*, *Ricinus communis*, *Musa sapientum*, *Ipomoea batatas*, *Carica papaya*, *Citrus sinensis* and *Piper betle*.

The following plants failed to be infected : *Pennisetum typhoides*, *Eleusine coracana*, *Oryza sativa*, *Amorphophallus campanulatus*, *Colocasia artiquorum*, *Lycopersicum esculentum* and *Allium sativum*.

All the plants that were successfully inoculated have been cited as hosts of *M. phaseoli* by Young (1949) except one, *viz.*, *Paspalum scrobiculatum* ; on the other hand, *Lycopersicum esculentum* and *Allium sativum*, cited as hosts by Young (*ibid*) failed to be inoculated in the present investigation.

Reaction of different cotton species, varieties and strains to the fungus

The reaction of various species, varieties and strains of cotton to root-rot was investigated in the Punjab by Luthra and Vasudeva (1941) ; all the varieties, strains etc., tested by them proved susceptible. In the present experiment a very large number of varieties and strains of *Gossypium herbaceum*, *G. arboreum* and *G. hirsutum* as also other species of *Gossypium* were tested for their reaction to the fungus under conditions of artificial infection. The plants were raised in galvanised iron cans, inoculated when 15 days old and transferred to soil temperature tanks maintained at 28° C. The following species, varieties and strains were tested :

1. *Gossypium arboreum* :
   - (*i*) Varieties and strains from Cotton Breeding Station, Jalgaon. .. 15
2. *Gossypium herbaceum* :
   - (*i*) Varieties, strains and crosses from Cotton Breeding Stations, Viramgam 88
   - (*ii*) Varieties and strains from Cotton Breeding Station, Broach. 8
3. *Gossypium hirsutum* :
   - (*i*) Varieties received from the U.S.A. 18
   - (*ii*) Varieties received from the Cotton Breeding Station, Viramgam .. 4
4. *Gossypium barbadense* :
   - (*i*) Varieties received from Cotton Breeding Station, Surat 4
5. *Gossypium davidsoni*
6. *Gossypium raimondii.*
7. *Gossypium anomalum.*
8. *Gossypium thunberi.*
9. *Gossypium darvinii.*
10. *Gossypium stocksii.*

Without exception, all species varieties, crosses and strains proved susceptible.

Taxonomy and nomenclature

The fungus causing root-rot in cotton is a cosmopolitan parasite affecting many hosts in unrelated families and genera. Besides causing root-rot in cotton it also incites 'Charcoal-rot', seedling blight, stem rot and fruit rot of at least 284 species of plants in many parts of the world (Young 1949). The fungus has been called by three different names by various workers ; it was originally called *Sclerotium bataticola* by Taubenhaus (1913), later changed to *Rhizoctonia bataticola* (Taub.) Butler. Ashby (1927) found pycnidia and spores and established that they were formed by the same fungus producing sclerotia and hence called the spore producing strains *Macrophomina phaseoli.*

The oldest name of this fungus is *Macrophoma phaseoli* Maublanc but since it could not be distinguished from other species of *phoma* and *Macrophoma*, the new generic name *Macrophomina* was coined. Reichert and Hellinger (1927) suggested that the pycnidia and sclerotia forming strains of the fungus should be called *Macrophomina* (Sclerotium) *phaseoli* (Maubl) Ashby, whereas Kendrick. (1933) opposed use of the binomial *Macrophomina phaseoli* for strains forming sclerotia alone. On the other hand, Hansen and Valleau (1937) could not accept the name *Rhizoctonia bataticola* since in their opinion, the former generic name *Rhizoctonia* could be used only for such fungi which were shown to be imperfect stages of Basidiomycetes whereas strains of *R. bataticola* forming pycnidia could not, for obvious reasons, be such imperfect stages. To overcome the impasse created by this controversy, the opinion of Young (1949) seems to be the most logical, which is adoption of the well-known policy of *nomina conservanda* in Botanical Nomenclature, hence the binomial *Macrophomina phaseoli* (Maubl.) Ashby is preferred by him with which decision the authors are led to agree.

The main criteria for delimiting and differentiating pathogenic fungi belonging to the same taxonomic unit such as a genus or a species are, namely, (1) pathogenicity, (2) morphological and cultural characters, and (3) physiological characters. Applying these criteria to *Macrophomina phaseoli* and the fungus isolated from cotton and studied by the authors the following differences and similarities are brought out :

(1) **Pathogenicity** : The cotton root-rot organism studied resembles *Macrophomina phaseoli* in all respects including host-range.

(2) **Morphological and cultural characters** : The morphological and cultural characters of the fungus studied and of *Macrophomina phaseoli* are alike except size of pycnidiospores. The pycnidiospores of the fungus studied are smaller than those of *Macrophomina phaseoli* and the difference is statistically significant. Further, its mycelium is also slightly different in its form than that of *Macrophomina phaseoli*, being persistent and 'fumaceous'.

(3) **Physiological characters** : As regards physiological characters, the fungus under study differs from *Macrophomina phaseoli* in its ability to utilise lactose, production of erepsin and blackening of tyrosine. These differences, though not as important as morphological differences, are, nevertheless, striking. It is, therefore, proposed to name the fungus under study as a variety of *Macrophomina phaseoli* and the name *Macrophomina phaseoli* (Maubl.) Ashby var. *indica* n. var. is porposed for it.

Macrophomina phaseoli (Maubl.) Ashby var *indica* n. var.

Mycelium perdurans et fumaceum ; pycnidiosporae 15.9 × 5.8 μ. Lactosum adhibitum ; erepsenum productum, tyrosinum nigrum effectum.

In radicibus viventibus *Gossypii herbacei G. arborei* et *G. hirsuti* in regionibus ommibus producentes *Gossypium* in Maharashtra et Gujarat in India.

Typus, Moniz 155, lectus die 15 Septembris anni 1954 positus in herbario Collegii Agriculturae ad Poona, in India ; isotypus, Moniz 155 positus in Herbario Cryptogamico Indiae Orientalis ad New Delhi, in India.

Mycelium persistent and fumaceous ; pycnidiospores 15.9 × 5.8 μ. Lactose utilized ; erepsin produced ; tyrosine turned black.

In roots of living plants of *Gossypium herbaceum ; G. arboreum* and *G. hirsutum* in all cotton growing regions of Maharashtra and Gujarat States of India. Type specimens collected by Moniz 155, on the 15th

September 1954 and deposited in the herbarium of the College of Agriculture, Poona, India, and similar specimens deposited also in Herbarium Cryptogamic India Orientalis, New Delhi, India.

Summary

Root-rot, caused by *Macrophomina phaseoli* (Maubl.) Ashby, is a serious disease of indigenous cotton in Maharashtra and Gujarat States and differs from a similar disease of cotton in the Punjab.

The causal fungus was isolated in pure culture.

A technique for reproducing the disease under artificial conditions was evolved ; so far it had not been possible to reproduce root-rot artificially.

The morphological, cultural and biochemical characters of the pathogen were studied along with the type culture of *M. phaseoli*. The two fungi are very much alike except that the pycnidiospores of the fungus investigated are smaller. Also, its mycelium is persistent and fumaceous. The fungus, unlike *M. phaseoli*, can utilise lactose, produces erepsin and tyrosine is blackened.

The disease reaches maximum development at a soil temperature of 28°C. and 20 per cent soil moisture.

All 143 varieties, strains and crosses of cotton belonging to 10 species of *Gossypium* proved susceptible to the fungus in glasshouse tests at 28°C. soil temperature. In the host range studies *Pennisetum typhoides*, *Eleusine coracana*, *Oryza sativa*, *Amorphophallus campanulatus*, *Colocasia antiquorum*, *Lycopersicum esculentus* and *Allium sativum* did not take up infection but *Paspalum scrobiculatum* proved to be a new host.

On the basis of smaller size of its pycnidiospores and physiological characters which are not found in *M. phaseoli*, the fungus investigated has been made a new variety with the name *Macrophomina phaseoli* (Maubl.) Ashby var. *indica* n. var. A diagnosis of this new variety is given.

Since writing this paper, Kulkarni *et al* (1962)* have claimed that they have evolved a 'new' technique for inciting root-rot of cotton artificially. A critical comparison of this 'new' technique with the one reported in the present paper will bring out that there is nothing new in the 'new' method wherein mycelial bits from a growing culture of *Macrophomina phaseoli* are—"—placed on the surface of the soil in close contact with the collar of the seedlings and covered completely with sterilized soil", whereas in the technique used in the present work—"—some soil near the root zone of young cotton seedlings growing in steamed soil was carefully lifted, the mycelial mat was placed in the cavity and the soil returned to its position". Since both methods can bring about 100 per cent infection, the superiority of the 'new' method for artificial inoculation is debatable.

---

* Kulkarni, N. B., Patil, B. C. and Sulaiman, M. (1962). Pycnidial formation by *Macrophomina phaseoli* on artificially inoculated cotton ; Phytopath. **52** : 369-371.

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Received : November, 1962

[Jour. Indian Chem. Soc., Vol. 40, No. 1, 1963]

11306

JOSHI, K.C. & GIRI, S. (Univ. Gorakhpur, U.P., India). 1963

Organic pesticides. Part XIII. Synthesis of some new fluoro-ketones and their thiosemicarbazones.

J. Indian chem. Soc., 40 (1): 42-44, 3 tables, 1963.

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Five representative thiosemicarbazones have been evaluated as antifungal chemicals against *Alternaria solani* by agar-plate technique.

EXPERIMENTAL

Fluoro-ketones

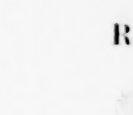
An appropriate hydrocarbon (1*M*) was subjected to the Friedel-Crafts reaction in presence of anhydrous aluminium chloride (1.5*M*) and an acid chloride (1*M*). After decomposing the resulting complex with ice-cold HCl, the product separating was isolated by the usual procedure. The ketones thus obtained are listed in Table I.

Thiosemicarbazones of Fluoro-ketones

These were prepared according to the method of Scott and McCall[4]. A solution of an appropriate ketone (1*M*) in ethanol was treated with an ethanolic solution of thiosemicarbazide (1.1*M*). After refluxing for 20 to 30 minutes, the thiosemicarbazones were isolated by the usual method. These are recorded in Table II.

1. Siegler *et al.*, *J. Econ. Entomol.*, 1942, **35**, 74.
2. U. S. P. 2,426,349/1947.
3. Bun-Hoi *et al.*, *J. Chem. Soc.*, 1956, 713.
4. *J. Amer. Chem. Soc.*, 1945, **67**, 1767.

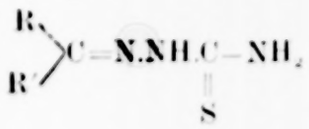
TABLE I



No.	R′.	M.P.	Yield.	Formula.	%Carbon. Found.	%Carbon. Reqd.	%Hydrogen. Found.	%Hydrogen. Reqd.
				R=4-Fluoro-P.				
1.	2′-Chloro-P	58-59°	51%	$C_{13}H_8OClF$	65.89	66.53	3.10	3.41
2.	4′-Nitro-P	180-82°	46	$C_{13}H_8O_3FN$	63.24	63.67	3.02	3.27
3.	3′-Chloro-P	126-27°	58	$C_{13}H_8OClF$	65.92	66.53	3.21	3.41
4.	3′-Methyl-P	95-96°	52	$C_{14}H_{11}OF$	78.02	78.50	4.61	5.14
				R=2-Fluoro-5-methoxy-P.				
5.	β-Pyridyl	120-21°	49	$C_{13}H_{10}O_2NF$	67.01	67.53	4.31	4.33
				R=4-Fluoronaphthyl.				
6.	2′-Chloro-P	182°	61	$C_{17}H_{10}OClF$	71.01	71.70	3.22	3.51
7.	4′-Methoxy-P	229-30°	63	$C_{18}H_{13}O_2F$	76.09	77.14	4.14	4.64
8.	β-Pyridyl	218-19°	47	$C_{16}H_{10}ONF$	75.74	76.49	3.28	3.98
9.	Phenyl	81-82°	69	$C_{17}H_{11}OF$	80.32	81.60	4.02	4.40
10.	Ethyl	110°	65	$C_{13}H_{11}OF$	77.49	77.22	5.24	5.44

N.B. P denotes phenyl.

TABLE II



No.*	M.P.	Yield.	Formula.	% Sulphur. Found.	% Sulphur. Reqd.
1	171°	60%	$C_{14}H_{11}N_3ClFS$	9.48	10.40
2	167-68°	71	$C_{14}H_{11}O_2N_4F$	10.38	10.96
3	122-23°	62	$C_{14}H_{11}N_3ClFS$	10.04	10.40
4	102-103°	54	$C_{15}H_{14}N_3FS$	10.80	11.14
5	135-36°	49	$C_{14}H_{13}ON_4FS$	10.64	10.52
6	173-75°	64	$C_{18}H_{13}N_3ClFS$	8.18	8.95
7	170°	43	$C_{19}H_{16}ON_3FS$	9.56	9.07
8	176-78°	50	$C_{17}H_{13}NF_4S$	9.06	9.87
9	148-50°	62	$C_{18}H_{14}N_3FS$	9.13	9.80
10	160°	39	$C_{14}H_{14}N_3FS$	11.02	11.63

*The number corresponds to that of ketone compound recorded in Table I.

[Jour. Indian Chem. Soc., Vol. 40, No. 1, 1963]

Organic Pesticides. Part XIII. Synthesis of Some New Fluoro-ketones and their Thiosemicarbazones

K. C. Joshi and S. Giri

Several new fluoro-ketones and their thiosemicarbazones have been prepared. Antifungal activity of five of the thiosemicarbazones has been evaluated against *Alternaria solani*.

The ketones, aldehydes, their semicarbazones, and thiosemicarbazones often exhibit interesting biological properties owing to the presence of toxophoric >C=O and >N-C-S groupings respectively. This is apparent from their use as larvicides[1], insecticides[2], fungicides, and bactericides[3]. It was therefore thought worthwhile to synthesise and study the pesticidal properties of some new fluoro-ketones and their thiosemicarbazones, as detailed information pertaining them seems lacking in the literature.

The fluoro-ketones have been prepared by the Friedel-Crafts acylation of appropriate hydrocarbons. On refluxing with an ethanolic solution of thiosemicarbazide[4], the ketones have readily furnished the corresponding thiosemicarbazones.

Five representative thiosemicarbazones have been evaluated as antifungal chemicals against *Alternaria solani* by agar-plate technique.

EXPERIMENTAL

Fluoro-ketones

An appropriate hydrocarbon (1*M*) was subjected to the Friedel-Crafts reaction in presence of anhydrous aluminium chloride (1.5*M*) and an acid chloride (1*M*). After decomposing the resulting complex with ice-cold HCl, the product separating was isolated by the usual procedure. The ketones thus obtained are listed in Table I.

Thiosemicarbazones of Fluoro-ketones

These were prepared according to the method of Scott and McCall[4]. A solution of an appropriate ketone (1*M*) in ethanol was treated with an ethanolic solution of thiosemicarbazide (1.1*M*). After refluxing for 20 to 30 minutes, the thiosemicarbazones were isolated by the usual method. These are recorded in Table II.

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2. U. S. P. 2,386,349/1947.
3. Buu-Hoï *et al.*, *J. Chem. Soc.*, 1956, 713.
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TABLE I

No.	R′.	M.P.	Yield.	Formula.	%Carbon. Found.	%Carbon. Reqd.	%Hydrogen. Found.	%Hydrogen. Reqd.
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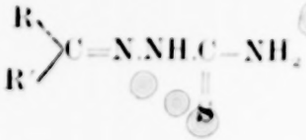
2.	4′-Nitro-P	180-82°	46	$C_{13}H_8O_3FN$	63.24	63.67	3.02	3.27
3.	3′-Chloro-P	126-27°	58	$C_{13}H_8OClF$	65.92	66.53	3.21	3.41
4.	3′-Methyl-P	95-96°	52	$C_{14}H_{11}OF$	78.02	78.50	4.61	5.14
				R = 2-Fluoro-5-methoxy-P.				
5.	β-Pyridyl	120-21°	49	$C_{13}H_{10}O_2NF$	67.91	67.53	4.31	4.33
				R = 4-Fluoronaphthyl.				
6.	2′-Chloro-P	162°	61	$C_{17}H_{10}OClF$	71.01	71.70	3.22	3.51
7.	4′-Methoxy-P	229-30°	63	$C_{18}H_{13}O_2F$	76.09	77.14	4.14	4.64
8.	β-Pyridyl	218-19°	47	$C_{16}H_{10}ONF$	75.74	76.49	3.28	3.98
9.	Phenyl	81-82°	69	$C_{17}H_{11}OF$	80.32	81.60	4.02	4.40
10.	Ethyl	110°	65	$C_{13}H_{11}OF$	77.28	77.22	5.24	5.44

N.B. P denotes phenyl.

TABLE II



No.*	M.P.	Yield.	Formula.	%Sulphur. Found.	%Sulphur. Reqd.
1	171°	60%	$C_{14}H_{11}N_3ClFS$	9.48	10.40
2	167-68°	71	$C_{14}H_{11}O_2N_4F$	10.38	10.06
3	122-23°	62	$C_{14}H_{11}N_3ClFS$	10.04	10.40
4	102-103°	54	$C_{15}H_{14}N_3FS$	10.80	11.14
5	135-36°	49	$C_{14}H_{13}ON_4FS$	10.64	10.52
6	173-75°	64	$C_{18}H_{13}N_3ClFS$	8.18	8.95
7	170°	43	$C_{19}H_{16}ON_3FS$	9.56	9.07
8	176-78°	50	$C_{17}H_{13}NF_4S$	9.86	9.87
9	148-50°	62	$C_{18}H_{14}N_3FS$	9.13	9.86
10	160°	39	$C_{14}H_{14}N_3FS$	11.02	11.63

*The number corresponds to that of ketone compound recorded in Table I.

Evaluation of Fungicidal Activity

The antifungal activity of the five thiosemicarbazones was evaluated against the fungus *Alternaria solani* by the agar-plate technique[5].

The Difco potato dextrose agar of *p*H 5.6 was inoculated with the spores of *A. solani*. The inoculum was mixed with the melted, cooled agar, poured into sterilised petri plates, and allowed to harden. As soon as the agar had hardened, the test compound (approx. 0.1 g.) was placed over 1 cm^2 area on the surface of the agar. The plates were incubated for five days at 25°. At the close of the incubation period, the width of the zone of the inhibition surrounding each test compound was noted. The compounds were tested without dilution. The results of this screening are recorded in Table III.

TABLE III

No.	Compound.	Width of zone of inhibition.
1	4-Fluoronaphthylphenyl-KT	10 mm
2	3-Chlorophenyl-4-fluorophenyl-KT	23
3	4-Nitrophenyl-4-fluorophenyl-KT	19
4	Ethyl-4-fluoronaphthyl-KT	9
5	β-Pyridyl-4-fluoronaphthyl-KT	10

N.B. KT denotes ketone thiosemicarbazone.

The results indicate that the compounds exhibit excellent fungicidal properties and they warrant further screening at higher dilutions and against a wider spectrum of fungi.

The authors wish to thank Dr. R. A. Kubista, Head Bacteriologist at Wisconsin Alumni Research Foundation, U. S. A., for technical assistance in screening the toxicity of the compounds, Dr. R. C. Mehrotra, Ex-Professor and Head of the Department of Chemistry, for providing necessary facilities, and the Scientific Research Committee, U.P., for a contingency grant.

ORGANIC CHEMISTRY LABORATORIES,
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Received September 15, 1962.

5. U. S. D. A. Circular No. 198, 1931.

[Jour. Indian Chem. Soc., Vol. 40, No. 1, 1963]

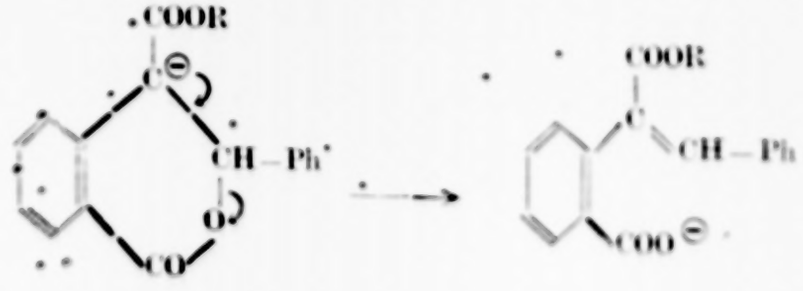
Stobbe Reactions with Diethyl Homophthalate. Part I

J. N. Chatterjea, K. D. Banerji, and H. Mukherjee

The Stobbe condensations of diethyl homophthalate with a few aldehydes and ketones (including cyclic ketones) have been studied. The application of the reaction in the synthesis of some polycyclic compounds has been investigated.

Although the esters of glutaric acid cannot be used in the Stobbe type of condensations, derivatives of glutaconic acid have been successfully used by Ruzicka *et al*[1,2]. Homophthalic acid, which may be regarded as the benzologue of glutaconic acid, has also been used in the Stobbe type condensations by Mueller[3] and Dieckmann[3]. The potentiality and usefulness of the reaction were explored by Lowenthal and Pappo[4] by carrying out condensation of homophthalic esters with cyclohexanone, acetone, benzophenone, and benzaldehyde respectively, using sodium hydride as the condensing agent. In all cases they obtained the expected half-esters in excellent yields.

In common with the classical Stobbe condensations with succinic esters (cf. Johnson and Daub[7]), the condensations with homophthalic esters appear to proceed through stabilisation of the intermediate lactones of the type (I) (from benzaldehyde and homophthalic ester) which is irreversibly cleaved by basic catalysts to the half-ester (II). Incidentally, the esters of phenylacetic acid also undergo aldol-type of condensation although the reactivity is much less pronounced.



(I) (II)

We have studied the condensations of cinnamic aldehyde and terephthaldehyde with diethyl homophthalate which lead to the formation of half-esters (III: R = Et) and

1. *Helv. Chim. Acta*, 1949, **12**, 1020.
2. *Annalen*, 1938, **191**, 251.
3. *Ber.*, 1914, **47**, 3432.
4. *J. Chem. Soc.*, 1952, 4706.
5. Chatterjea and Mukherjee, this *Journal*, 1960, **37**, 370.
6. *Idem*, *ibid.*, 1960, **37**, 443.
7. "Organic Reactions", Wiley, Vol. VI, p. 1.

Evaluation of Fungicidal Activity

The antifungal activity of the five thiosemicarbazones was evaluated against the fungus *Alternaria solani* by the agar-plate technique[5].

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TABLE III

No.	Compound.	Width of zone of inhibition.
1	6-Fluoronaphthylphenyl-KT	10 mm
2	3-Chlorophenyl-4-fluorophenyl-KT	23
3	6-Nitrophenyl-4-fluorophenyl-KT	19
4	Ethyl-4-fluoronaphthyl-KT	9
5	β-Pyridyl-4-fluoronaphthyl-KT	10

N.B. KT denotes ketone thiosemicarbazone.

The results indicate that the compounds exhibit excellent fungicidal properties and they warrant further screening at higher dilutions and against a wider spectrum of fungi.

The authors wish to thank Dr. R. A. Kubista, Head Bacteriologist at Wisconsin Alumni Research Foundation, U. S. A., for technical assistance in screening the toxicity of the compounds, Dr. R. C. Mehrotra, Ex-Professor and Head of the Department of Chemistry, for providing necessary facilities, and the Scientific Research Committee, U.P., for a contingency grant.

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Received September 15, 1962.

5. U. S. Dept. of Circular No. 198, 1931.

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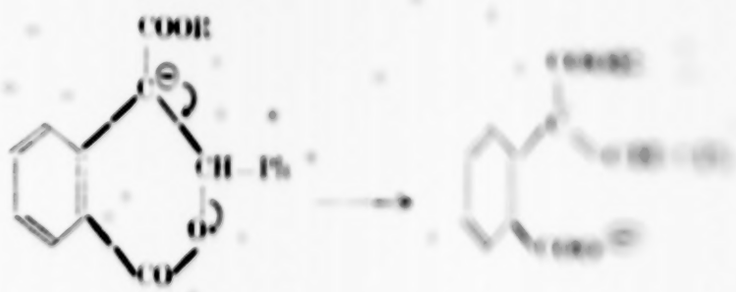
Stobbe Reactions with Diethyl Homophthalates, Part I

J. N. Chatterjea, K. D. Banerji, and H. Mukherjee

The Stobbe condensations of diethyl homophthalate with a few aldehydes [illegible] ketones) have been studied. The application of the reaction in the synthesis of [illegible] has been investigated.

Although the esters of glutaric acid cannot be used in the [illegible] tions, derivatives of glutaconic acid have been successfully used by [illegible] phthalic acid, which may be regarded as the homologue of glutaconic [illegible] used in the Stobbe type condensations by Mueller[1] and [illegible] usefulness of the reaction were explored by Lowenthal and [illegible] condensation of homophthalic esters with cyclohexanone, acetone, [illegible] benzaldehyde respectively, using sodium hydride as the [illegible] cases they obtained the expected half-esters in excellent yields.

In common with the classical Stobbe condensations with [illegible] son and Daub[7]), the condensations with homophthalic esters [illegible] stabilisation of the intermediate lactones of the type [illegible] homophthalic ester) which is irreversibly cleaved by [illegible] Incidentally, the esters of phenylacetic acid also undergo [illegible] although the reactivity is much less pronounced.



I II

We have studied the condensations of cinnamic aldehyde [illegible] with diethyl homophthalate which lead to the formation of half-esters [illegible]

1. *Helv. Chim. Acta*, 1949, **12**, 1920.
2. *Annalen*, 1931, **491**, 251.
3. *Ber.*, 1914, **47**, 1432.
4. *J. Chem. Soc.*, 1952, 4799.
5. Chatterjea and Mukherjee, this *Journal*, 1960, **37**, [illegible]
6. *Idem.*, *ibid.*, 1960, **37**, 443.
7. "Organic Reactions", Wiley, Vol. VI, p. 1.